NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND

(No.)
Code 378

DEFINITION

A water impoundment made by constructing a dam or an embankment or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by combining the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at spillway elevation is 3 feet or more.

PURPOSE

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- To provide water for livestock.
- Fish and wildlife.
- Recreation.
- Fire protection.
- Irrigation.
- Crop and orchard spraying.
- To maintain or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard establishes the minimum acceptable quality for the design and construction of ponds if:

1. Failure of the dam will not result in loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.

2. The product of the storage (acre-ft) times the effective height (ft) of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the emergency spillway. The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.

3. The effective height of the dam is 35 ft or less, and the dam is hazard class (a).

Site conditions. Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed emergency spillway, (2) a combination of a principal spillway and an emergency spillway, or (3) a principal spillway.

Drainage area. The drainage area contributing to the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and groundwater flow will maintain an adequate supply of water in the pond for the intended purpose. The water quality shall be suitable for the intended use.

Reservoir area. The topography and soils of the site shall permit storage of water at a depth and volume that ensures a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

CRITERIA

General Criteria Applicable to All Purposes

All planned work shall comply with all Federal, state, and local laws and regulations.

Protection. The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded or sodded as necessary to prevent erosion. Areas shall be vegetated in accordance

with NRCS conservation practice standard for Critical Area Planting, Code 342.

Visual resource design. The visual design of ponds shall be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

CRITERIA FOR EMBANKMENT PONDS

Site Investigation. Field soil borings will be made in the embankment foundation, emergency spillway, and any borrow locations. Borings for the embankment are usually along the centerline and used to determine if an adequate cutoff can be constructed. Borings in the emergency spillway and borrow areas are used to determine the adequacy of material to be used in the foundation cutoff trench and embankment. A permanent record of all soil borings and test pits made in the reservoir area, embankment foundation, borrow area, and emergency spillway area shall be maintained in the design folder.

Foundation cutoff. A cutoff of relatively impervious material shall be provided under the dam if necessary. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and shall be deep enough to extend into a relatively impervious layer and provide for a stable dam when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes of the cutoff trench shall be safe and in no case shall be not be steeper than one horizontal to one vertical (1:1).

Seepage control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage creates swamping downstream, (3) such control is needed to ensure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment drains; (2) reservoir blanketing; or (3) a combination of these measures.

Earth embankment. The minimum top width for a dam is shown in Table 1. If the embankment top is to be used as a public road, the minimum width shall be 16 feet for one-way traffic and 26 feet for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority.

Table 1 - Minimum top width for dams

Total height of embankment, ft	Top width, ft
< 10	6
10 to < 15	8
15 to < 20	10
20 to < 25	12
25 to < 35	14
35	15

Side slope. The combined upstream and downstream side slopes of the settled embankments shall not be less than five horizontal to one vertical (5:1). Neither slope shall be steeper than two horizontal to one vertical (2:1). All slopes must be designed to be stable, even if flatter side slopes are required. Dams to be mowed should have three horizontal to one vertical (3:1) side slopes or flatter.

Wave protection. Where needed to protect the slopes of the dam, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided (see NRCS Technical Releases 56 and 69).

Freeboard. The minimum elevation of the top of the settled embankment shall be 1 foot above the water surface in the reservoir with the emergency spillway flowing at design depth. The minimum difference in elevation between the crest of the emergency spillway and the settled top of the dam shall be 2 feet for all dams having more than a 20 acre drainage area or more than 20 feet in effective height.

Settlement. The design height of the dam shall be increased by the amount needed to ensure that after settlement the height of the dam equals or exceeds the design height. This increase shall not be less than 5 percent, except where detailed soil testing and laboratory analyses show that a lesser amount is adequate.

Principal spillway. A pipe conduit, with needed appurtenances, shall be placed under or through the dam, except where rock, concrete, or other types of mechanical spillways are used, or where the rate and duration of flow can be safely handled by a vegetated or earth spillway without erosion. Vegetated or earth spillways will not be adequate without a pipe spillway if long duration, continuous, or frequent flows are expected.

The principal spillway crest elevation shall be no less than 0.5 foot below the crest of the

emergency spillway for dams having a drainage area of 20 acres or less, and no less than 1 foot for those having a drainage area of more than 20 acres.

When design discharge of the principal spillway is considered in calculating peak outflow through the emergency spillway, the crest elevation of the inlet shall be such that full flow will be generated in the conduit before there is discharge through the emergency spillway. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the emergency spillway. The diameter of the pipe shall not be less than 4 inches. All pipe sizes may be considered when the routed design hydrographic is used to design the emergency spillway.

Pipe conduits under or through the dam shall be capable of withstanding external loading without yielding, buckling, or cracking and must be watertight. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 5 percent deflection. The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe. All pipe joints shall be made watertight by the use of couplings, gaskets, caulking, or by welding.

For dams 20 feet or less in effective height, acceptable pipe materials are cast-iron, welded steel, corrugated steel or aluminum, concrete, plastic including polyvinyl chloride (PVC) and high density polyethylene (HDPE), and cast-in-place reinforced concrete. Plastic pipe that will be exposed to direct sunlight should be made of ultraviolet resistant materials or be protected by coating or shielding; or provisions made as necessary for replacement. Connections of plastic pipe to less flexible pipe or structures must be designed to avoid stress concentrations that could rupture the plastic.

For dams more than 20 feet in effective height, conduits shall be plastic, reinforced concrete pipe, cast-in-place reinforced concrete, corrugated steel or aluminum, or welded steel pipe.

The maximum height of fill over any principal spillway steel or aluminum pipe must not exceed 25ft. PVC and HDPE pipe shall meet the requirements in Table 2 and steel and aluminum pipe shall meet the requirements in Table 3.

The joints between sections of pipe shall be designed to remain watertight after joint elongation caused by foundation consolidation. Concrete pipe shall have concrete bedding or a concrete cradle, if required. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe, non-eroding outlet.

Table 2. - Acceptable plastic pipe for use in earth dams[1/]

Type of plastic pipe	Nominal pipe size, in	Maximum depth of fill over pipe, ft
SDR 26 (160 psi)[1/]	6 - 12	10
Schedule 40 (180 psi)[1/]	6 - 12	10
Schedule 80 (280 psi)[1/]	6 - 12	15
PVC[2/]	4 - 18	15
PVC[2/]	24 - 36	10
HDPE[2/]	4 - 18	15
HDPE[2/]	24 - 36	10

1/ Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ATSM-D1785 or ATSM-D2241.

2/ Polyethylene, Type III, Class C, Category 4 or 5 conforming to ASTM D1248 and D3350 and AASHTO M252 or M294, Type S: PVC; ASTM F949.

Protective coatings of asphalt or polymer on galvanized corrugated metal pipe, or coal tar enamel on welded steel pipe should be provided in areas that have a history of pipe corrosion, or where the saturated soil resistively is less than 4,000 ohms-cm, or where soil pH is lower than 5.

Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistively studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be used on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need. NRCS conservation practice standard 430-FF provides criteria for cathodic protection of welded steel pipe.

A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by State law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

Table 3. - Minimum gage for corrugated metal pipe [2-2/3-in x ½-in corrugations][1/]

Fill height (ft)	Min. gauge for steel pipe Diameter in inches					Min. thickness (in) of aluminum pipe [2/] Diameter in inches			
	≥ 24	30	36	42	48	≥ 21	24	30	36
1 to < 15	16	16	14	12	10	0.06	0.06	0.075	0.075
15 to < 20	16	16	14	12	10	0.06	0.075	0.105	0.105
20 to ≤ 25	16	14	12	10	10	0.06	0.105	0.135	----[3/]

1/ Pipe with 6-, 8-, and 10-inch diameters has 1-1/2 in x ¼-in corrugations.

2/ Riveted or helical fabrication.

3/ Not permitted.

Supply pipes through the dam to watering troughs and other appurtenances shall have an inside diameter of not less than 1.25 inches.

The pipe conduit shall have a minimum slope of 0.5 foot per 100 feet (after foundation settlement) to provide positive drainage.

Seepage control. Seepage control along a pipe conduit spillway shall be provided if any of the following conditions exist:

1. The effective height of dam is greater than 15 feet.
2. The conduit is of smooth pipe larger than 8 inches in diameter.
3. The conduit is of corrugated pipe larger than 12 inches in diameter.

Seepage along pipes extending through the embankment shall be controlled by use of a filter and drainage diaphragm, unless it is determined that antiseep collars will adequately serve the purpose.

The drainage diaphragm is to consist of sand, meeting fine concrete aggregate requirements in ASTM C-33 (at least 15% passing the No. 40 sieve but no more than 10% passing the No. 100 sieve). If unusual soil conditions exist, a special design analysis shall be made. The drainage diaphragm shall be a minimum of 2 feet thick and extend vertically upward and horizontally at least three times the pipe diameter, as measured from the outside of the pipe, and vertically downward at least 18 inches beneath the conduit invert. The drainage diaphragm shall be located immediately downstream of the cutoff trench and approximately parallel to the centerline of the dam.

The drain shall outlet at the embankment downstream toe, preferably using a drain backfill envelope continuously along the pipe to where it exits the embankment. Protecting drain fill from surface erosion will be necessary.

When antiseep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall not exceed 14 times the minimum projection of the antiseep collar measured perpendicular to the pipe. Antiseep collar material shall be compatible with pipe materials. The antiseep collar(s) shall increase the seepage path along the pipe by a minimum of 15%.

Antivortex devices. Closed conduit spillways designed for pressure flow must have adequate antivortex devices.

Trash guard. To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser. The trash guard shall be designed and constructed in such a manner that flow to the inlet will not be adversely affected.

Emergency spillways. An emergency spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The minimum criteria for the use of a closed conduit principal spillway without an emergency spillway is as follows:

1. a closed conduit with a cross-sectional area of 3 square feet or more,
2. an inlet that will not clog, and
3. an elbow designed to facilitate the passage of trash

The minimum capacity of a natural or constructed emergency spillway shall be that required to pass the peak flow or routed hydrographic expected from a design storm of the frequency and duration shown in Table 4. All principal spillway pipe sizes can be routed.

The emergency spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start either with

the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days' drawdown, whichever is higher. The 10-day drawdown shall be computed from the crest of the emergency spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower.

Emergency spillways shall provide for passing the design flow at a nonerosive velocity to a point downstream where the dam will not be endangered. Constructed emergency spillways are open channels that consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth. The side slopes shall be stable for the material in which the spillway is to be constructed. For dams having an effective height exceeding 20 feet, the emergency spillway shall have a bottom width of not less than 10 feet.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed emergency spillway shall fall within the range established by discharge requirements and permissible velocities.

Structural emergency spillways. If chutes or drops are used for principal spillways or emergency spillways, they shall be designed according to the principles set forth in the National Engineering Handbook (NEH), Part 650-Engineering Field Handbook for Conservation Practices and the National Engineering Handbook-Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 4, less any reduction creditable to conduit discharge and detention storage.

EXCAVATED PONDS

Site Investigation. Site suitability and design shall be based on adequate investigations and surveys as described in the National Engineering Handbook, Part 650-Enginerring Field Handbook for Conservation Practices, Chapter 11, Ponds and Reservoirs.

Runoff. Provisions shall be made for a pipe and emergency spillway if necessary. Runoff flow patterns and ground water recharge rate shall be considered when locating the excavated pond and placing the spoil (see Table 4).

Side slopes. Side slopes of excavated ponds shall be stable and shall not be steeper than one horizontal to one vertical (1:1). If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to a depth of 3 feet below the anticipated low water elevation at a slope no steeper than three horizontal to one vertical (3:1).

Perimeter form. If ponds are to be used for recreation or are highly visible to the public, the perimeter or edge should be curvilinear.

Inlet protection. If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

Table 4. -Minimum spillway capacity

			Minimum design storm frequency 2/		
Drainage	**Effective height of dam 1/**	**Storage**	**Principal**	**Emergency**	**Minimum**
acre	ft	ac-ft	yr	yr	hr
≤ 20	≤ 20	< 50	2	10	24
≤ 20	> 20	< 50	2	25	24
> 20 to ≤ 100	≤ 20	< 50	2	25	24
> 20 to ≤ 100	> 20	< 50	2	50	24
> 100 to < 250	≤ 20	< 50	5	25	24
> 100 to < 250	> 20	< 50	5	50	24
≥250	≤ 20	< 50	10	25	24
All Others			10	50	24

1/ As defined under "Conditions"

2/ Select rain distribution based on climatological region

Excavated material. The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and so that it will not erode back into the pond by rainfall. It shall be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 feet, with the top graded to a continuous slope away from the pond.
2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 feet from the edge of the pond.
3. Shaped to a designed form that blends visually with the landscape.
4. Used for low embankment and leveling.
5. Hauled away.

Visual resources design. The visual design of ponds shall be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

Additional Criteria for Irrigation

The capacity of the pond shall be adequate to meet the irrigation requirement of the planned crop(s). The required capacity shall be based on the irrigation requirements of the crops to be irrigated, the effective rainfall expected during the growing season, the application efficiency of the irrigation method used, the losses due to evaporation and seepage, and the expected inflow into the pond.

Additional storage shall be provided for the estimated volume of sediment that will be deposited during the life of the structure.

CONSIDERATIONS

Ponds will affect the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge. Generally the peak discharge will be reduced and in many instances reduced to zero during dry periods that could affect other water uses or users. There may be an increase in recharge to the ground water since most pond seep and the base flow may extend for a longer period of time. Effects on the volume of downstream flow may prohibit undesirable environmental, social or economic effects.

Ponds have the potential for multiple uses. Storage requirements for each purpose should be considered to ensure an adequate water supply for all intended uses. Ponds used for multiple uses should be compatible.

Properly designed ponds will trap nutrients, sediments and pesticides. Therefore chemical concentrations will normally be higher in the pond area and lower in the downstream channel section.

This practice will affect the visual quality of onsite and downstream water resources. The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

Short-term and construction-related effects of this practice may affect the quality of downstream water courses.

Surface water temperature of the pond will increase and may affect the temperatures of downstream water and cause undesired affects on aquatic and wildlife communities.

Ponds constructed in upland areas may have a positive affect on wildlife habitats.

Ponds constructed in wetland areas must be evaluated to ensure the net wetland benefits are maintained or increased.

Where water must be conveyed for use elsewhere, such as for irrigation or fire protection, ponds should be located as close to the point of use as feasible.

Ponds used for public recreation should have minimum facilities such as access roads, parking areas, boat ramps or docks, and drinking and sanitary facilities. Where areas are used for swimming, safety signs should be installed indicating the depth of water and flatter side slopes should be installed for safety. Water should be tested for quality on a regular basis.

During the construction of ponds, there is the potential for earth moving to uncover or redistribute toxic materials.

Due consideration should be given to economics and safety and health factors.

PLANS AND SPECIFICATIONS

Plans and specifications for installing ponds shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. Copies of the plans and specifications shall be given to the landuser.

OPERATION AND MAINTENANCE

An operation and maintenance plan will be made for each structure site and given to the landuser. All ponds must be adequately maintained if their purposes are to be realized through the expected life. Special considerations shall be given for maintenance needs during the planning, design, and construction of the pond.

The pond should be inspected periodically and especially after heavy rains to determine whether it is functioning properly or if repairs are needed.

Appurtenances such as trashracks, outlet structures, and valves shall be kept free of trash and replaced when needed.

Rills on the slopes of the dam and eroded areas in the earth spillway shall be filled with suitable material, compacted, seeded and fertilized as needed. Should the upstream face of the dam erode due to wave action, protection such as riprap may be needed. If seepage through or under the dam occurs, proper corrective measures shall be taken immediately.

The vegetative cover of the dam and earth spillway shall be maintained by mowing and fertilizing or burning when needed. Trees can cause leaks and safety hazards and should not be permitted on the embankment or in the emergency spillway.

When needed, fencing and watering troughs will be provided to protect the pond and vegetation from livestock.

REFERENCES

ASTM C-33

NRCS National Engineering Handbook (NEH)

Part 650- Engineering Field Handbook,
Chapter 11, Ponds and Reservoirs
Section 5, Hydraulics
Section 11, Drop Spillways
Section 14, Chute Spillways

NRCS Conservation Practice Standards

Critical Area Planting, Code 342
Irrigation Water Conveyance, Steel, 430-FF